



At-Risk Safety Metric

A Proactive Safety Measurement Strategy

presented by

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Measuring the Level of Safety in Aviation Operations

There is an industry-wide struggle to accurately:

- *Determine the level of safety of operations*
- *Identify the true causes of unsafe conditions*
- *Measure and trend operational safety*



The Problem With Measuring Safety

Traditionally, safety is measured reactively...

- ✓ after an accident, incident, or injury occurs
- ✓ investigations stop after identifying “who” made the error
- ✓ interventions focus on proximate conditions not the real “root cause” of the event
- ✓ prevention strategies generally do not change unsafe behaviors



How Safe Is Your Operation?

When asked what the level of safety is at their operation, most managers can only report...

“We haven’t had an (accident, aircraft damage, injury) for (1,2,6...weeks, months)”

Such “bad outcomes” are rare enough that they provide little insight into how to effectively prevent errors!



Maintenance Human Error Iceberg

Accident / Incidents

1

Reportable Events

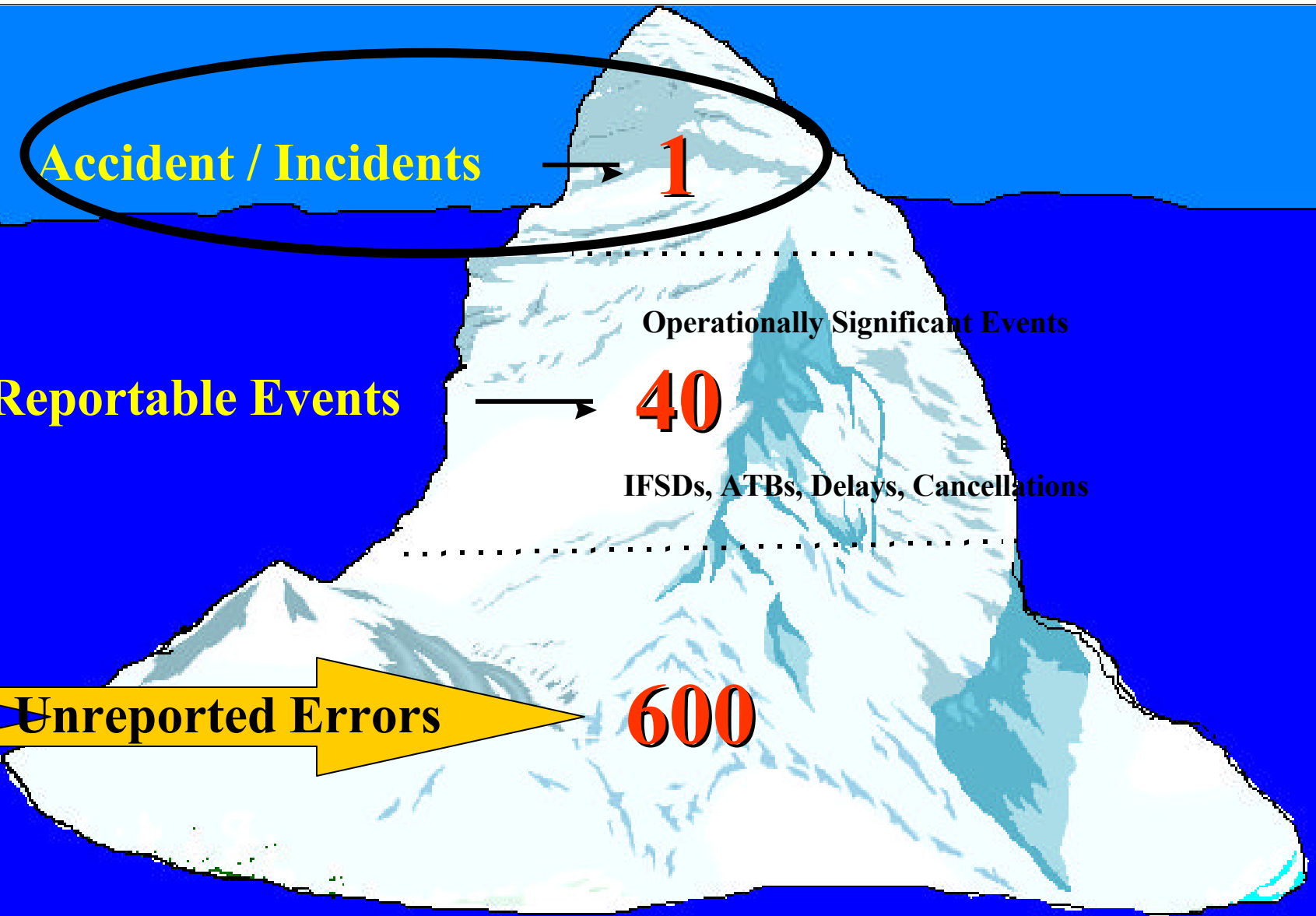
40

Operationally Significant Events

IFSDs, ATBs, Delays, Cancellations

Unreported Errors

600





What's the difference between...

Circumstances

Accidents

Incidents

?

Personal Injuries

Reportable Events

Unreported Errors

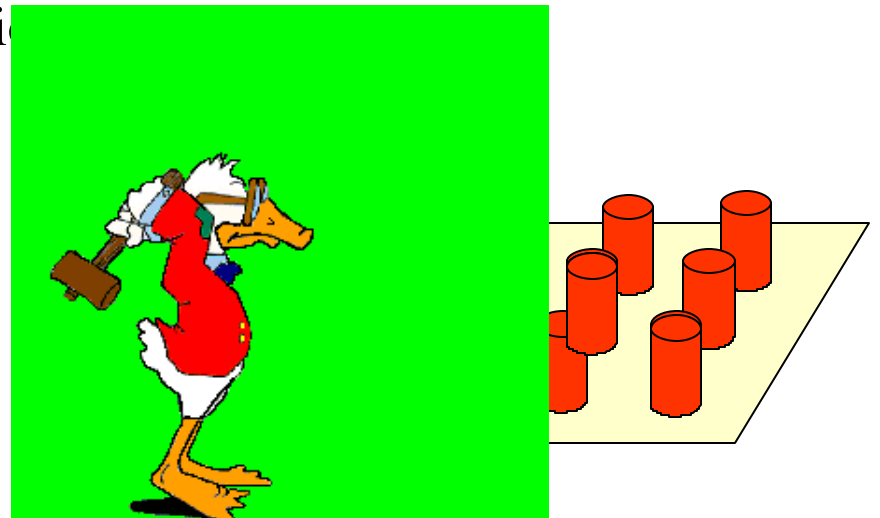


Results of Reactive Approach

Safety measurements based only on accidents & incidents

- Allow analysis only after a “bad outcome” has resulted
- Does not provide enough data to accurately trend error potentials
- Provides little insight into “root causes” of unsafe acts
- Does not accurately identify conditions

Like the “*Gopher Game*” at an arcade, prevention strategies based on such measurements are always trying to catch-up with errors





To Move Toward a Proactive Safety Strategy

We need:

- ✓ A comprehensive safety information database
- ✓ To identify the “root causes” of errors
- ✓ Change worker behaviors
- ✓ Address organizational conditions which promote errors
- ✓ Develop a method for real-time monitoring and continual improvement of operational safety
- ✓



Need More Information...

Need a more robust database of errors/causes...

- ✓ Accidents / incidents historic data
- ✓ Aircraft & ground equipment damage
- ✓ Personal injury
- ✓ “Near-miss” and safety concern reports
- ✓ Real-time assessment of “at-risk” worker behaviors and operational safety levels



...which leads to effective solutions

To be effective, safety measurements should:

- Accumulated records in a common database
- Provide a common classification scheme of “root causes”
- Periodically report “top” safety problems to promote targeted interventions
- Trend safety levels to show improvements and areas of opportunity



Maintenance Human Error Iceberg

We need to look more closely at *Unreported Incidents*

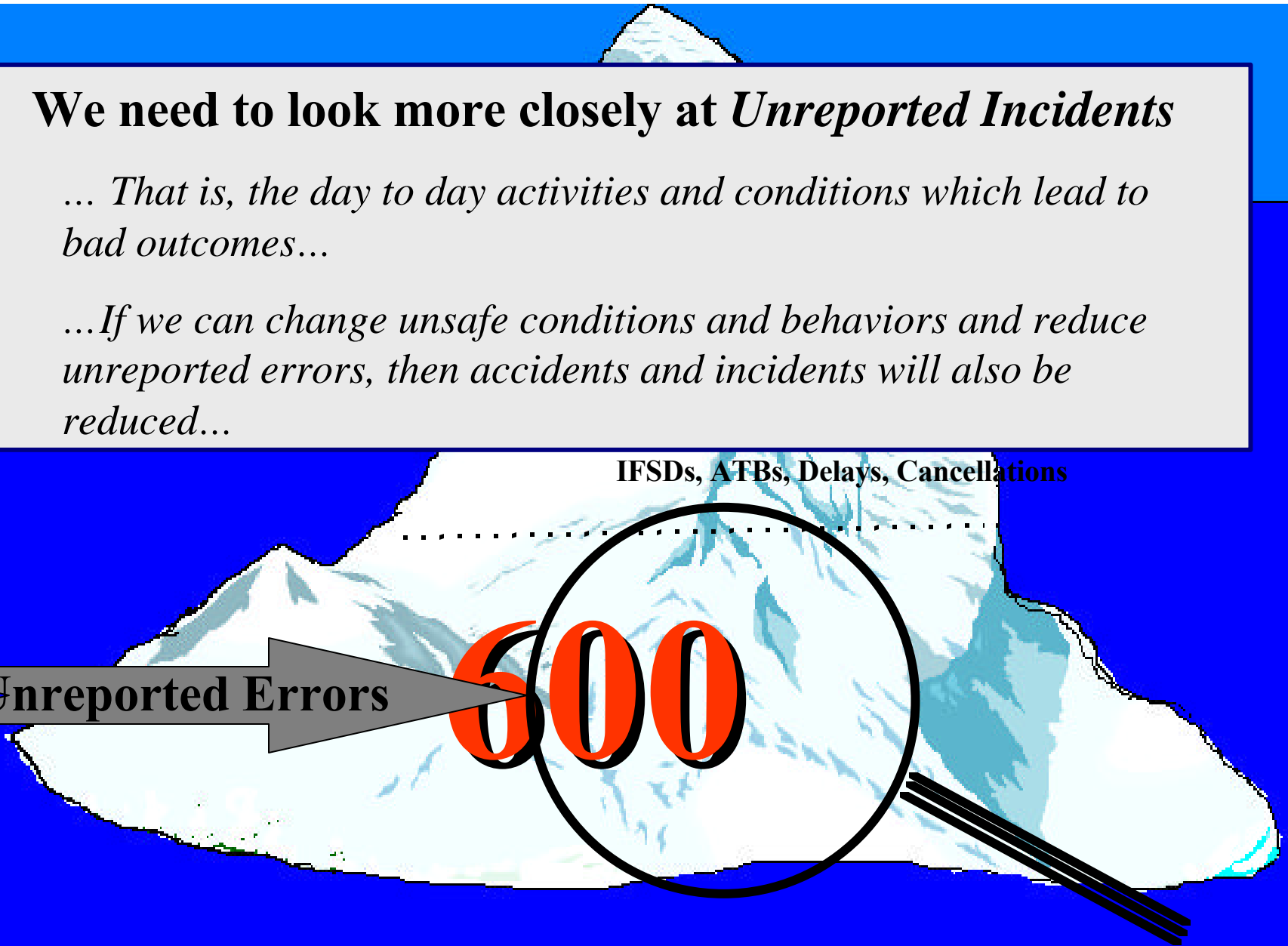
... That is, the day to day activities and conditions which lead to bad outcomes...

...If we can change unsafe conditions and behaviors and reduce unreported errors, then accidents and incidents will also be reduced...

IFSDs, ATBs, Delays, Cancellations

Unreported Errors

6000





Assessing Safety in Real-Time!

Aviation work environments are in a constant state of change... to truly *prevent* future errors, we must...

- accurately assess current levels of safety
- identify emerging error potentials
- adjust error management strategies to meet changing needs

We must be able to measure safety in “real-time”!



The Missing Tool for a Proactive Approach to Safety

The key to unlocking a truly proactive approach to managing errors lies in being able to monitor:

- ✓ Workers' at-risk behaviors
 - ✓ the operation's level of unsafe acts & errors
- ...day-to-day in the workplace.





Purdue's Safety Metrics System

Goal – Design a Safety Metric which will:

- ✓ Measure the level of unsafe acts (real-time)
- ✓ Identify the most common sources of errors
- ✓ Target “top three” at-risk behaviors for each career group for intervention strategies
- ✓ Monitor and report changes in error potentials
- ✓ Trend safety level over time to show progress



At-Risk Behavior Safety Audit

Safety in “real-time”

- A Beginning -

Previous Research - Actions of workers which most often lead to errors, incidents, accidents...

- Not following procedures
- Knowingly taking risks
- Loss of situational awareness
- Not adhering to accepted safety practices



To Be Measurable; at-risk behaviors must be

Observable – through

- physical actions
- records / reports
- work related outcomes

(Can not measure things like)

- intentions
- thoughts

Clearly Identifiable

Unambiguous



Defining the “at-risk” behaviors to be measured...

Working with the industry partner team...

Identify common errors which lead to unsafe acts

- ✓ Review historic data to identify common errors
- ✓ Define work process and safe practices
- ✓ Evaluate policies & procedures

Determine which at-risk behaviors can be observed

Fully define observable indicators of at-risk behaviors

Develop observational checklist





Sample Safety Observation Checklists

Selected At-Risk Behaviors

Maint. ARRIVALS				Safety Observation Checklist											
Ver 2.1 01-16-00															
DATE:		TIME:													
FLIGHT:		GATE:													
Aircraft Arrivals				Terminal	Hanger	A/C Move	Personal Accountability	Not Following Procedure	Communication	Incompatible Goals	Work Process Design	Training	Equipment	Interline Operations	Construction
No Co. approved hearing protection used															
AMT not on gate/hanger for arrival															
PLB not in box															
Fire extinguishers obstructed/not in correct position															
FOD walk not performed															
Improper envelope parking observed															
Envelope parking not enforced															
Improper guideman signals/ position															
Inappropriate wands used															
Proper chocks not used immediately after blocked															
PLB warning light & bell not used															
Arrival/FOA walkaround not performed															
FOA damage not reported/investigated															
Bypass pin not installed before towbar connect															
Streamer not installed on bypass pin															
AMT crossed over A/C towbar															
Comments/Others(Facilities,Airport Ops,etc...)															

VALS				Safety Observation Checklist												
Ver 2.1 01-17-00																
DATE:		TIME:														
FLIGHT:		GATE:														
Aircraft Arrivals				Terminal	Bag	FF	Fuel	Personal Accountability	Not Following Procedure	Communication	Incompatible Goals	Work Process Design	Training	Equipment	Interline Operations	Construction
No Co. approved hearing protection used																
Eq. not parked in designated area																
Eq. not positioned clear of the envelope																
Driving in front of aircraft during arrival																
Envelope incursion before chocked																
Warning light & bell not used																
No FOA check prior to Eq. moved into position																
FOA damage not reported appropriately																
Approach to A/C before engine shut down																
Improper positioning of eq. at aircraft																
Beltloader/Cargolader bumper contacting A/C																
Unnecessary driving under aircraft profile																
Personal items observed on vehicles																
Comments/Others(Facilities,Airport Ops,etc...)																



Sample Safety Observation Checklists

Company Defined Root Causes

Maint. ARR

Ver 2.1 01-16-00

DATE: TIME:

FLIGHT: GATE:

Aircraft Arrivals	Terminal	Hanger	A/C Move	Personal Accountability	Not Following Procedure	Communication	Incompatible Goals	Work Process Design	Training	Equipment	Interline Operations	Construction
No Co. approved hearing protection used												
AMT not on gate/hanger for arrival												
PLB not in box												
Fire extinguishers obstructed/not in correct position												
FOD walk not performed												
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PLB warning light & bell not used												
Arrival/FOA walkaround not performed												
FOA damage not reported/investigated												
Bypass pin not installed before towbar connect												
Streamer not installed on bypass pin												
AMT crossed over A/C towbar												
Comments/Others(Facilities,Airport Ops,etc...)												

Camp ARRIVALS Safety Observation Checklist

Ver 2.1 01-17-00

DATE: TIME:

FLIGHT: GATE:

Aircraft Arrivals	Terminal	Bag	FF	Fuel	Personal Accountability	Not Following Procedure	Communication	Incompatible Goals	Work Process Design	Training	Equipment	Interline Operations	Construction
No Co. approved hearing protection used													
Eq. not parked in designated area													
Eq. not positioned clear of the envelope													
Driving in front of aircraft during arrival													
Envelope incursion before chocked													
Warning light & bell not used													
No FOA check prior to Eq. moved into position													
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Comments/Others(Facilities,Airport Ops,etc...)													



Monitoring Unsafe Behaviors

Workplace safety observations

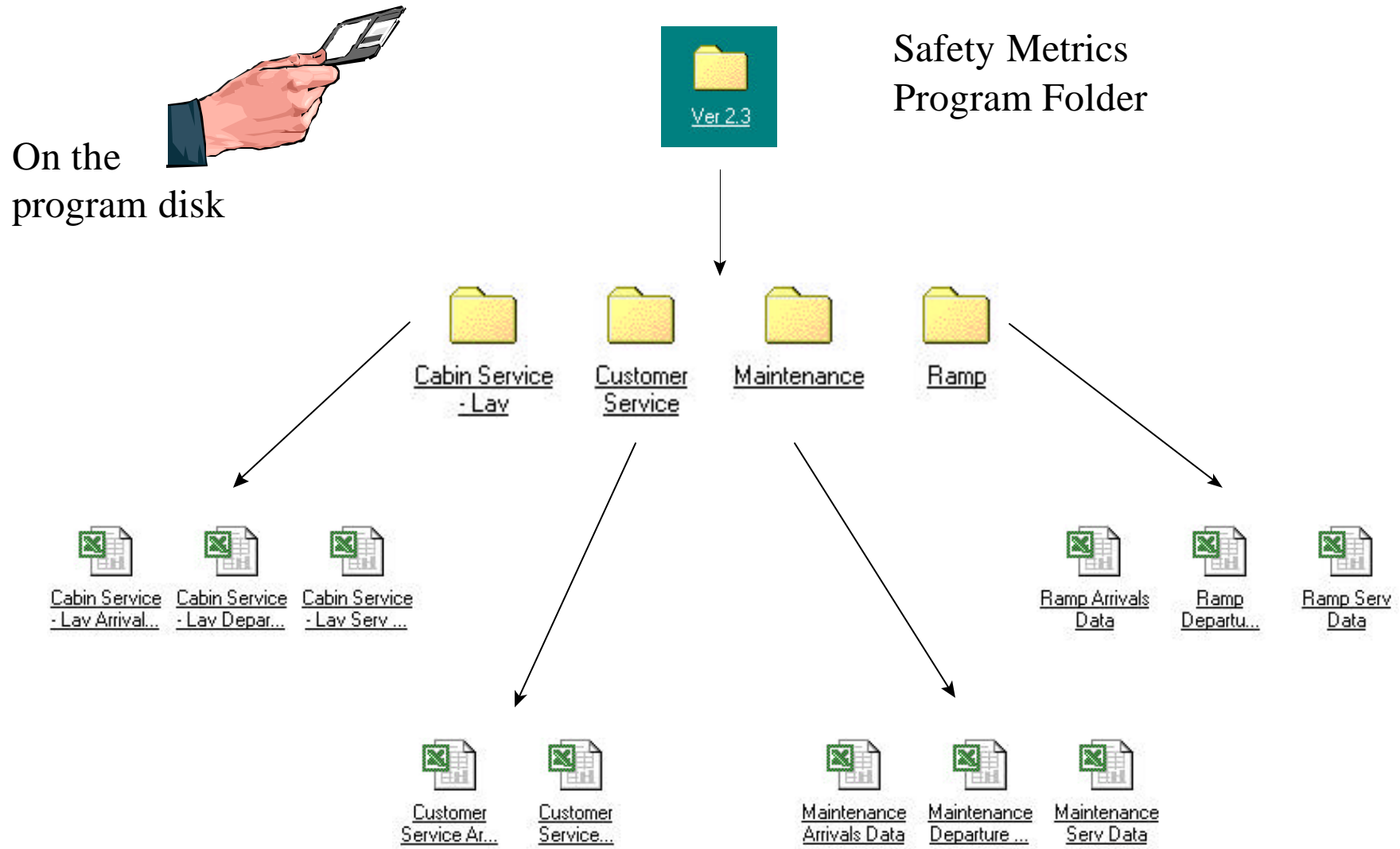


Each Day on Every Shift, members of the station's safety team:

- Observed at least 2 complete operations per career field per shift
- Recorded the number of occurrences of each at-risk behavior
- Monitored and recorded unsafe conditions in the workplace
- Performed worker interviews to determine “root causes” of behavior
- Provided immediate feedback and safety mentoring to workers



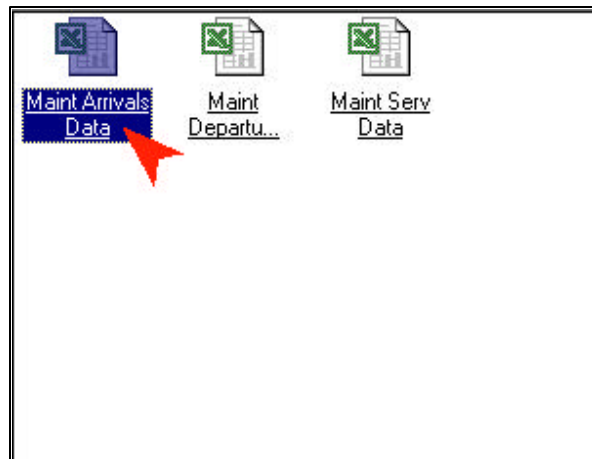
Safety Metrics Program Structure





Opening a data entry sheet

1. Open Microsoft Excel or simply open the desired file by double clicking the sheet's icon



Maint. ARRIVALS				Safety Observation Entry Sheet									
Ver 2.3 03-07-00				ENTER				COMPILE					
Number of Sheets to Enter----->				<input type="text" value="1"/>				Number of Flights per Day-----> <input type="text"/>					
				<div> <div>Personal Accountability</div> <div>Not Following Procedure</div> <div>Communication</div> <div>Incompatible Goals</div> <div>Work Process Design</div> <div>Training</div> <div>Equipment</div> <div>Interline Operations</div> <div>Construction</div> </div>									
Aircraft Arrivals				Terminal	Hangar	A/C Move							
No UAL approved hearing protection used													
AMT not on gate/hanger for arrival													
PLB not in box													
Fire extinguishers obstructed/not in correct position													
FOD walk not performed													
Improper envelope parking observed													
Envelope parking not enforced													
Improper guideman signals/ position													
Inappropriate wands used													
Proper chocks not used immediately after blocked													
PLB warning light & bell not used													
Arrival/FOA walkaround not performed													
FOA damage not reported/investigated													
Bypass pin not installed before towbar connect													
Streamer not installed on bypass pin													
AMT crossed over A/C towbar													



- | <div> <div>Maint. ARRIVALS</div> <div>Safety Observation Entry Sheet</div> </div> | | | | | | | | | | | | |
|---|----------|--------------------------------|----------|-------------------------|-------------------------|---------------|--------------------|---------------------|----------|-----------|----------------------|--------------|
| Ver 2.3 03-07-00 | ENTER | | COMPILE | | | | | | | | | |
| Number of Sheets to Enter-----> | 1 | Number of Flights per Day----> | | | | | | | | | | |
| Aircraft Arrivals | Terminal | Hangar | A/C Move | Personal Accountability | Not Following Procedure | Communication | Incompatible Goals | Work Process Design | Training | Equipment | Interline Operations | Construction |
| No UAL approved hearing protection used | 2 | | | | | 1 | | | | | | |
| AMT not on gate/hanger for arrival | | 1 | | 1 | | | | | | | | |
| PLB not in box | | | | | | | | | | | | |
| Fire extinguishers obstructed/not in correct position | 2 | | | | | | | | 1 | | | |
| FOD walk not performed | | | 2 | | 1 | | | | | | | |
| Improper envelope parking observed | | 3 | | | | 1 | | | | | | |
| Envelope parking not enforced | | | 1 | | | 1 | | | | | | |
| Improper guideman signals/ position | | 3 | | | 1 | | | 1 | | | 1 | |
| Inappropriate vands used | | | | | | | | | | | | |
| Proper chocks not used immediately after blocked | 1 | | | 1 | | | | | | 1 | | |
| PLB warning light & bell not used | | | | | | | | | | | | |
| Arrival/FOA walkaround not performed | | | | | | | | | | | | |
| FOA damage not reported/investigated | | | 2 | 1 | | | | | | | | |
| Bypass pin not installed before towbar connect | 1 | | | | | | 1 | | | 1 | | |
| Streamer not installed on bypass pin | | | | | | | | | | | | |
| AMT crossed over A/C towbar | | 1 | | | 1 | | | 1 | | | | |



Recording the number of observations

3. Record the number of observational checklists from which the data is being transferred

<i>Maint. ARRIVALS</i>		Safety Observation	
Ver 2.3 03-07-00			
	ENTER		
Number of Sheets to Enter----->	<input type="text" value="1"/>		

- The number of sheets entered is set to “1” by default
- BUT, if you combine more than one checklist together before transferring the data to the database, enter the total number of observation sheets represented by the data in this block
- Press “ENTER” button

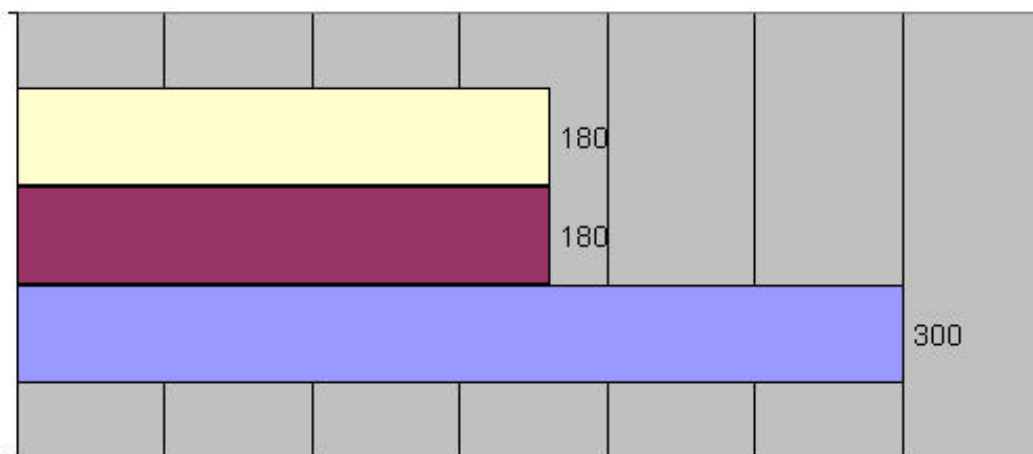
(NOTE - if the button does not work, make sure that no cell is still active with a blinking cursor)



- Number of Flights per Day----> 250

- Note - if the button does not work, make sure that no cell is still active with a blinking cursor*

Maint. Arrival Weekly Totals



Infractions per Day

- FOD walk not performed
- AMT not on gate/hanger for arrival
- Fire extinguishers obstructed/not in correct position

Fire extinguishers obstructed/not in correct position		AMT not on gate/hanger for arrival	
Root Cause Percentages		Root Cause Percentages	
Personal Accountability	0%	Personal Accountability	0%
Not Following Procedure	0%	Not Following Procedure	0%
Communication	0%	Communication	0%
Incompatible Goals	0%	Incompatible Goals	0%
Work Process Design	0%	Work Process Design	0%
Training	0%	Training	100%
Equipment	0%	Equipment	0%
Interline Operations	0%	Interline Operations	0%
Construction	100%	Construction	0%

FOD walk not performed	
Root Cause Percentages	
Personal Accountability	0%
Not Following Procedure	0%
Communication	100%
Incompatible Goals	0%
Work Process Design	0%
Training	0%
Equipment	0%
Interline Operations	0%
Construction	0%

If any of root cause boxes contain "DIV/0" it is not an error. It simply means that there is no data for that root cause.



Early Results...

After three months of observational safety audits...

- ✓ Workers & management more focused on safety
- ✓ Safety mentoring producing measurable behavioral changes in workers
- ✓ Error management interventions more easily definable
- ✓ Aircraft & equipment damage reduced
- ✓ Personal injuries reduced
- ✓ Measurable productivity improvements



Safety Metric Program - The Future

Opportunities for improvement:

- Observation training modules for observers
- Data-entry training for industry partner teams
- Strategy for adapting to new workplace settings
- Movement toward ACCESS based program
 - More user friendly
 - Multiple source database (accident, near-miss, etc.)
 - Searchable “comments” section
 - Linkable / sortable by “root causes”



Thank You

Aviation Human Factors Research Team

Aviation Technology Department, Purdue University